Optimization and the Psychology of Human Decision Making

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Abstract: Over the last years, psychological research has increasingly used computer-supported tests, especially in the analysis of complex human decision making and problem solving. However, two important questions can only be answered with the help of modern optimization methodology. The first one considers an analysis of the exact situations and decisions that led to a bad or good overall performance of test persons. Such an analysis must be based on sensitivity information.

The second important question concerns performance. For many complex scenarios the choices made by humans can only be compared to one another, but not to the optimal solution, as it is unknown. We want to solve the open question how much and in which situations optimization methods outperform human decisions. Both questions are addressed in an interdisciplinary project of mathematicians and psychologists.

We present a mathematical formulation of a test scenario that is in use in psychology since the eighties, the *Tailorshop*. Test persons are required to take business decisions to run a tailorshop. We show how mathematically this can be formulated as a discrete-time optimization problem,

$$\begin{array}{lllll} \max\limits_{x,u} & F(x_N) & & & \\ \text{s.t.} & x_{k+1} & = & G(x_{k+1}, x_k, u_k, p, RND), & k = 0 \dots N-1, \\ & u_{k,i} & \in & \Omega, & i = 1 \dots n_\Omega, \\ & 0 & \leq & H(x_k, u_k, p), & k = 0 \dots N, \end{array}$$

where F, G, and H are nonlinear functions, RND is a random variable, and Ω is a finite set. State variables are denoted by x_k, scenario parameters by p, and decisions to be taken by the test persons at time k by u_k. We discuss the modeling process, optimization results, and implications.

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